Standardization of the data in food and nutrition

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Food and nutrition composition data

Food

Quality

Safety

Authenticity

Traceability

Security

Sustainability

Nutrition

Evaluating nutritional variation of plants and foods

Analyzing relationships between nutrient intake and disease

Establishing dietary guidelines

Database

Scope

- One or multiple, Subject Official/commercial
- Rules, standard procedures for sample taking, traceable
- Shared Data, standardized
- Vocabulary, Ontology, Data Forest
- Which metadata

Inventory

- Inventory of existing Providers, Databases
- UE wide, Intersectoral

Management

- Ownership & access rights
- Quality management
- Founding
- Intellectual properties
- Legal framework
- Data providers

Architecture & IT

- Platform, software
- In fracture, architecture
- User-friendly
- Front and user interface

Validation

- Officially Recognized
- (Legally) trusted
- Validation, certification
- Interpretation & decision rules
- Standard lab methods

5 – 7 years

1.
Metrology in food

Robustness, performance, quality control

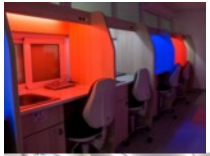
METROFOOD

Physical-RI ⇄ e-RI

Physical-RI

Metro

- **Plants and Labs for RM development**
  - RM Preparation
  - Stability and homogenity studies
- **Analytical Labs.**
  - Sampling, pretreatment and storage
  - Food composition and characterization
  - Inorganic contaminants
  - Organic contaminants
  - Chemical and biological markers and profiles
  - Microbiological analysis
  - Development of sensors and devices
  - Environmental Analysis
  - Testing (rheological, leaching, etc.)
  - Other



Food

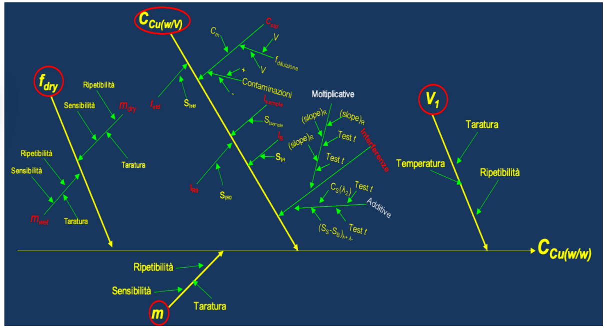
- **Experimental fields/farms**
  - Crop production
  - Animal breedings
  - Fish farms
- **Facilities for food processing and storage**
  - Industrial processing
  - Packaging
  - Supply chain and storage
  - Food preparation

e-RI

- **Software development**
  - development of new databases
  - Integration of existing databases
  - graphical interfaces development
  - database manteinance and updating
- **Data collection**
  - Reference Materials
  - Official and Reference Methods
  - Reference Laboratories
  - Vocabularies, Guidelines and procedures
  - PTs Providers
  - Food composition
  - Contaminants in food
  - Food markers
  - Characteristics of production areas and technologies
  - Food consumption
- **Data analysis**
- **Management of Interlaboratory tests**
- **Diffusion and Training**

Metrological tool

- Standard operational procedures
- Sampling & sample; pre-treatment procedures
- Reference materials
- Measurements uncertainty
- Proficiency testing



Development of new reference material METROFOOD-PP

- to demonstrate the capability of METROFOOD-RI to supply services (with particular reference to the P-RI) and to test its inter-operability

Oyster Tissue

Rice

Rice flour & rice grains
(same variety and same origin)

Two important issues:

- characterization of RM
- interlaboratory comparison

PRO METROFOOD
Progressing towards the construction of METROFOOD-RI

CLASS of PARAMETER		OYSTERS	RICE
Nutrients	Vitamins	5	7
	Fibres	4	6
	Others	6	7
Organic contaminants	Mycotoxins	-	8
	Residues antibiotics	4	8
	Others	6	7
Inorganic contaminants	Toxic elements	13	9
	Speciation	7	6
Contaminants of emerging concern		6	6
Origin/Authenticity/Isotopes		6	8
Others		3	3

Institution Abbreviation/ Country	Parameters for RM characterization				
	1	2	3	4	5
ENEA/IT (6 labs)			X	X	X
CNR/IT (6 labs)	X	X			X
INRIM/IT				X	X
ISS/IT (2 labs)		X	X		
CREA/IT (3 labs)	X	X			X
UniBS/IT			X		
INSA/PT	X		X	X	
IBA/RO	X	X	X		
CIDETEC/CIDETEC/ES		X	X		
UPPA/FR		X	X		X
LNE/FR		X	X		
ANSES/FR		X	X		
ADERA/UT2A/FR			X	X	X
AUTH/GR	X				
CULS/CZ	X		X		
USZ/HU		X	X	X	
TUM/DE		X			X
JSI/SI (2 labs)			X		X
NIB/SI		X			
ZRC Koper/SI	X	X			
IJZHP/MK	X		X		
FASF/MK	X				
WIV-ISP/BE		X	X		
TUBITAK/TR		X	X		
DAS/MD	X	X	X		

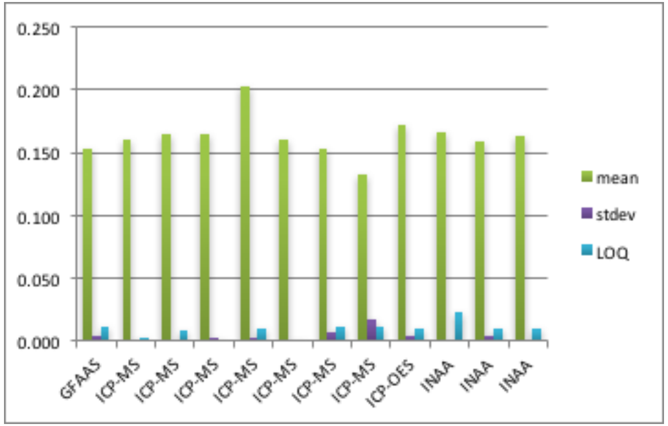
1 – nutritional and bioactive compounds
2 – organic contaminants and genetically modified organisms (GMO)
3 – inorganic contaminants
4 – contaminants of emerging concerns
5 – origin/authenticity/isotope

39 laboratories

First attempt ....

METHOD	lab	Test portion (g)[1]	Measurand (Analyte)	Unit[2]	Value 1	Value 2	Value 3	Value 4	Value 5	Mean value[3]	SD[3]
GFAAS	9	0.3	As	mg/kg	0.157	0.155	0.155	0.150	0.147	0.153	0.00414729
ICP-MS	10	0.4	As	mg/kg	0.160	0.160	0.160	0.160	0.160	0.160	0.000000
ICP-OES	14	0.4	As	mg/kg DW	0.177	0.171	0.167	0.169	0.176	0.172	0.00
ICP_MS	18	0.55	As	mg/kg	0.147	0.144	0.151	0.148	0.149	0.148	0.00273325
ICP_MS	18	0.55	As	mg/kg	0.154	0.157	0.153	0.153	0.154	0.154	0.00151877

	LAB	test portion	mean	stdev	LOQ
GFAAS	9	0.30	0.153	0.00415	0.012
ICP-MS	10	0.40	0.160	0.00000	0.003
ICP-MS	23	0.15	0.165	0.00075	0.009
ICP-MS	27	0.50	0.165	0.00289	0.001
ICP-MS	32	1.00	0.202	0.00252	0.010
ICP-MS	35	0.25	0.161	0.00141	0.002
ICP-MS	18	0.55	0.152	0.00757	0.011
ICP-MS	24	0.55	0.133	0.01679	0.011
ICP-OES	14	0.40	0.172	0.00436	0.010
INAA	23	0.32	0.167	0.00192	0.023
INAA	21	0.25	0.159	0.00491	0.010
INAA	21	0.25	0.164	0.00195	0.010
		mean	0.163		
		stdev	0.016		
		mean	0.162		
			0.006		
		%	3.764		



Protein content (%)

5 laboratories - numbers: 6, 7, 9, 15, 16

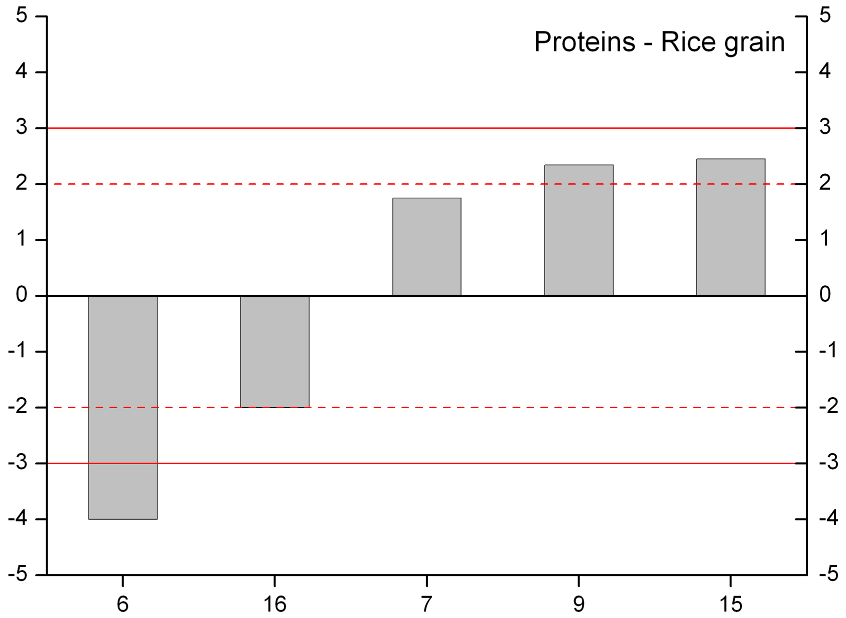
Sample mass: 0.5-1 g
Analysis: 5 replicates in 5 sample bottles
Method: Kjedahl Analiser

Lab.	Rice flour	Rice grains	Oysters
1			55.15
6	6.02	5.79	
7		6.94	54.10
9	7.15	6.95	53.00
15	7.31	7.08	54.94
16	6.89	6.19	
Mean	**6.84**	**6.59**	**54.30**
STD	**0.58**	**0.57**	**0.98**
Max	7.31	7.08	55.15
Min	6.02	5.79	53.00

PRO METROFOOD
Progressing towards the construction of METROFOOD-RI

Statistical evaluation

Lab. No.	Sample	Z-score
6	5.79	-4.00
16	6.19	-2.00
7	6.94	1.75
9	6.95	1.80
15	7.08	2.45



|z| ≤ 2 satisfactory result;

2 < |z| ≤ 3 questionable result (95 %);

|z| > 3 unsatisfactory result (99 %).

2.
Food authenticity and traceability

As an example

Food control system

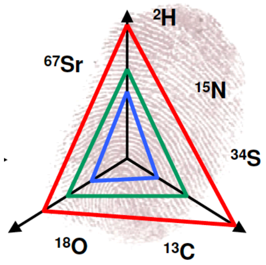
Overarching food control system needed

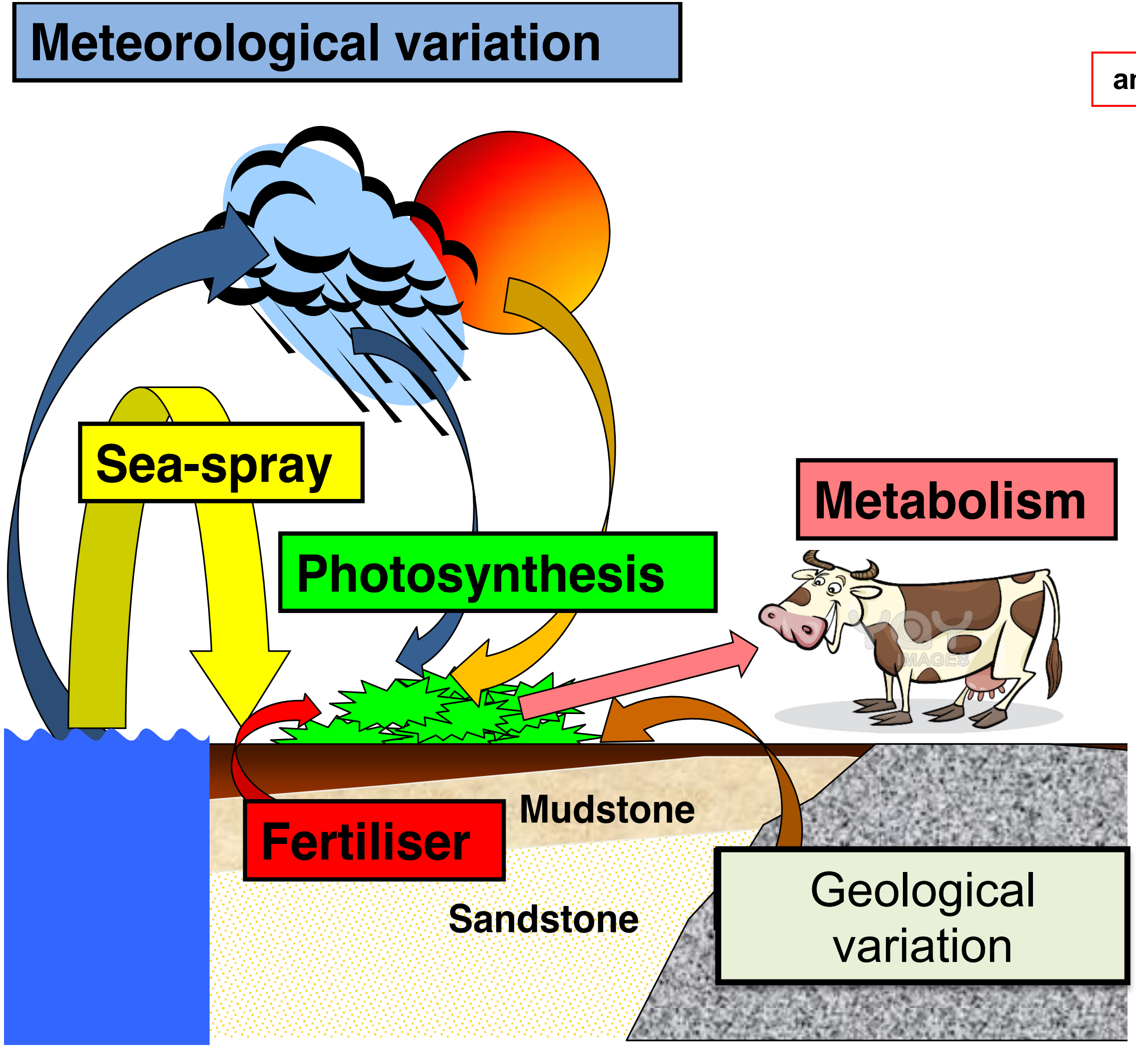
Traceability system

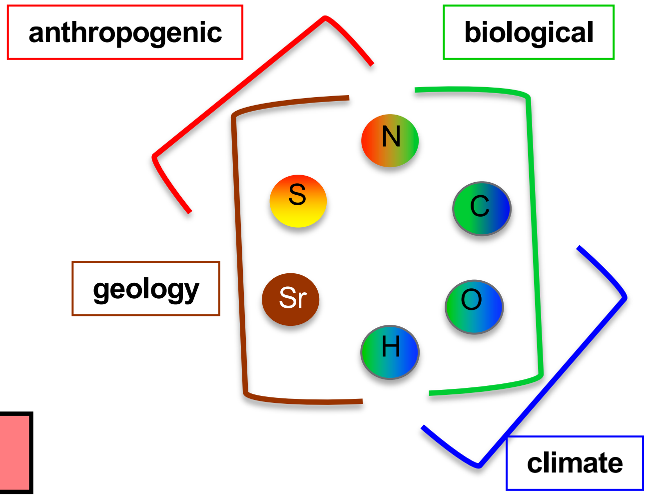
- labeling, radio-tagging
- good for passing information and tracking the packaging along the supply chain
- vulnerable to fraud

Robust analytical techniques for food origin or authenticity

Verify and support control system

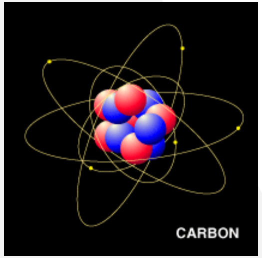



Meteorological variation
Sea-spray
Photosynthesis
Metabolism
Fertiliser
Mudstone
Sandstone
Geological variation

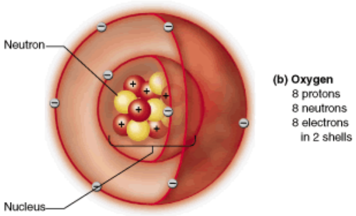

anthropogenic
biological
geology
climate
N
S
C
Sr
O
H

Terminology

Stable isotopes



^{12}C: 98.93 wt%
^{13}C: 1.07 wt%

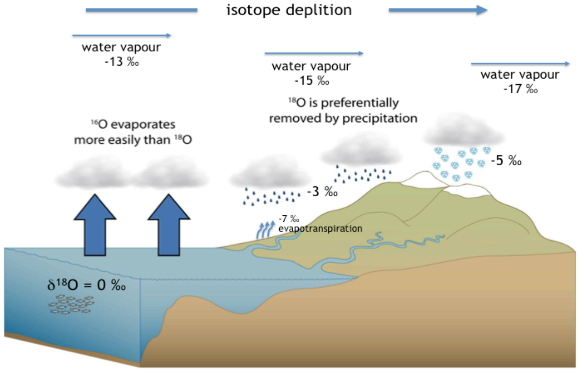


^{16}O: 99.757 wt%
^{17}O: 0.038 wt%
^{18}O: 0.205 wt%

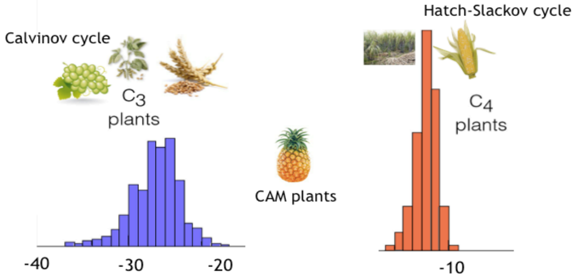
$$\delta X = \left(\frac{R_{sample}}{R_{standard}} - 1 \right) \times 1000 \quad [‰]$$

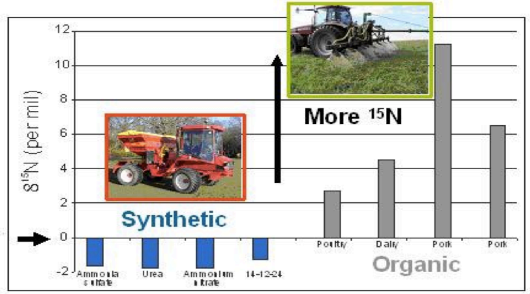
X = ^{2}H, ^{13}C, ^{15}N, ^{18}O, ^{34}S
R = $^{2}H/^{1}H$, $^{13}C/^{12}C$, $^{15}N/^{14}N$, $^{18}O/^{16}O$, $^{32}S/^{34}S$
Standard = V-SMOW, V-PDB, V-CDT, V-SMOC, AIR

Isotope	Fractionation
$^{2}H/^{1}H$ $^{18}O/^{16}O$	evaporation condensation precipitation
$^{13}C/^{12}C$	C4, C3 plants marine, terrestrial nutritional status
$^{15}N/^{14}N$	nitrification/denitrification trophic level marine, terrestrial



https://silentwitnesss.files.wordpress.com/2012/08/isotopes.jpg



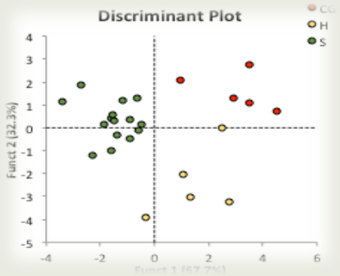


http://www.gns.cri.nz/var/ezwebin_site/storage/images/media/images/nitrogen/26338-1-eng-GB/nitrogen.jpg

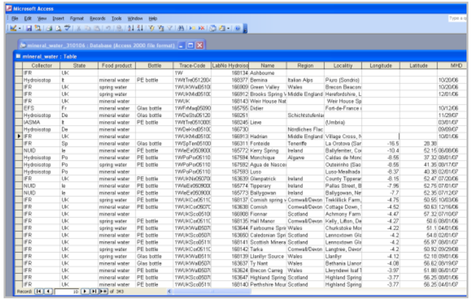
Origin – elemental and isotopic fingerprinting

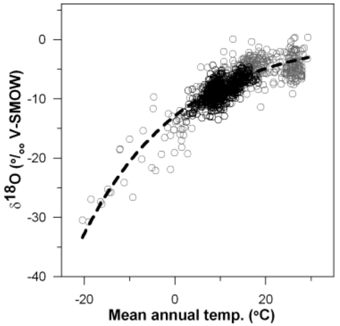
Sample → Multielement and isotope analysis + Chemometrics = Classification

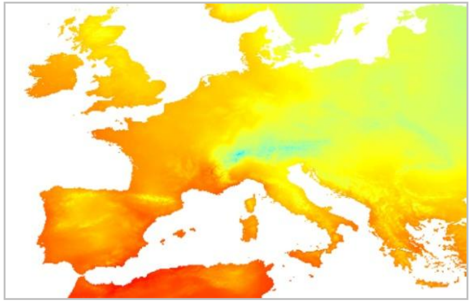
Sample	Multielement and isotope analysis	Chemometrics	Classification
Country Region Type …..	Elemental and isotope fingerprinting	PCA, CA, SIMCA, LDA, PLS-DA ….	Database matching Country X Region Y Type Z …..



Authenticity and provenience







What an “authentic sample” means

What are the factors influencing the isotope variability:

geographical origin, climatic conditions,

soil pedology and geology, for animal products, the diet type

any possible effects of processing technology

Large number of data (expensive)

Regular updates (stability of the data)

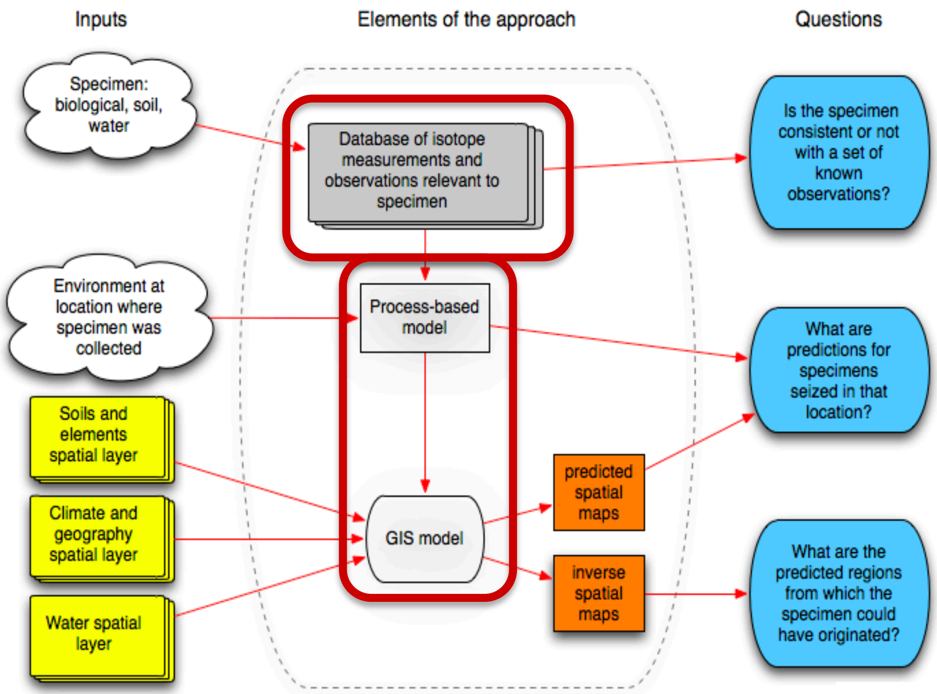
Origin is determined by comparing the data within a food to interpolated geo- climatic factors depicted in an isotopic map

Prediction of the data where no stable isotope data are available

Large scale data might overlook regionality

Annual/seasonal stability has to be proven

How is an isotope fingerprint interpreted?



Comparative applications

Are the isotope values of this scallop consistent with shellfish from Australia?

Are the isotope values of wines similar to others from the region?

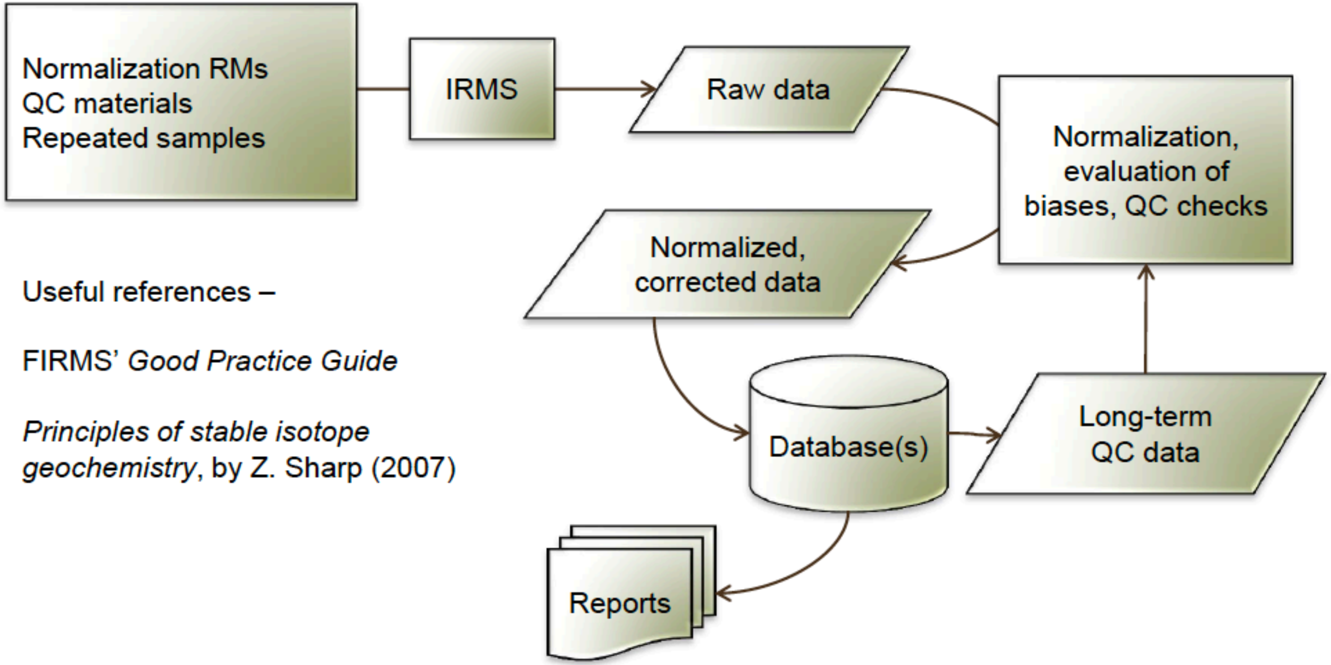
Predictive applications

What are the predicted isotope values of rice based on precipitation isotope values in Italy?

This olive oil doesn't match others from Italy. Where are the predicted regions where it may have originated?

A “good” database requires “good” data

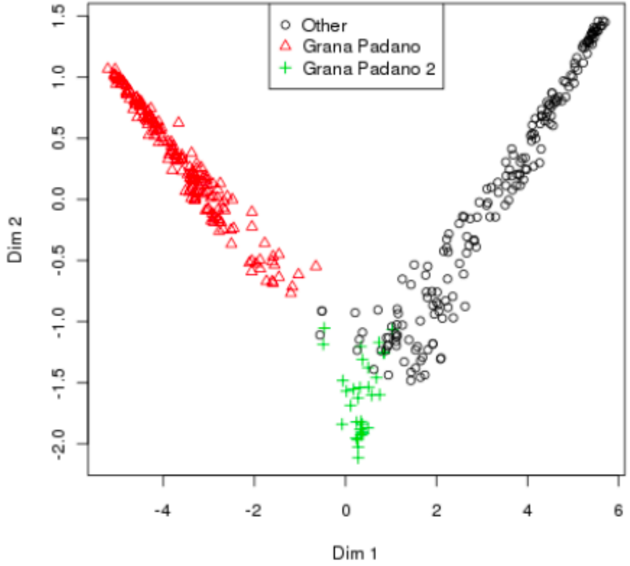
Example laboratory Quality Assurance Program



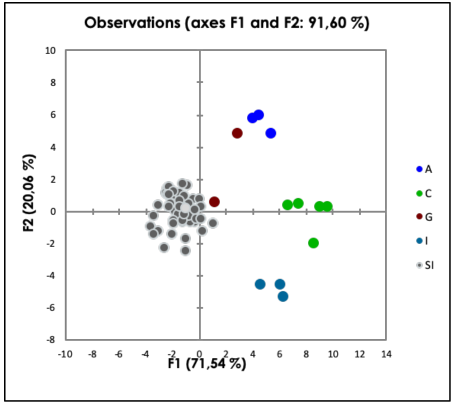
Useful references –

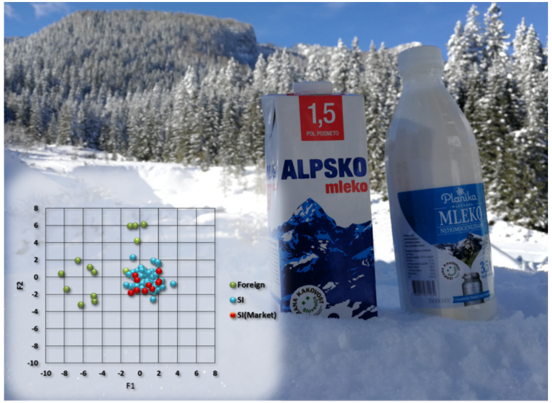
FIRMS’ *Good Practice Guide*

Principles of stable isotope geochemistry, by Z. Sharp (2007)



Random Forest Model (2011) for the traceability of Grana Padano cheese

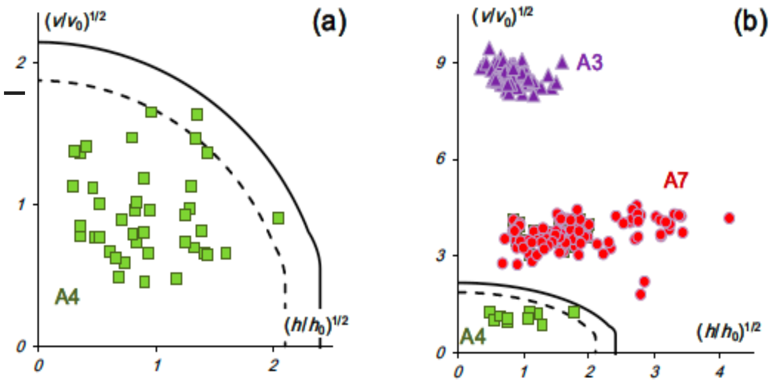




Slovenian milk

Stable isotope data + elemental composition – LDA

Authentification of Amplodipine tables – DD-SIMCA



(Hypothetical) example – build an oil isoscape

Source Water

Isotopic
composition of precipitation

"Climate"

Temperature,
precipitation amount

"Biology"

Biosynthetic
fractionation from plant
water to olive oil

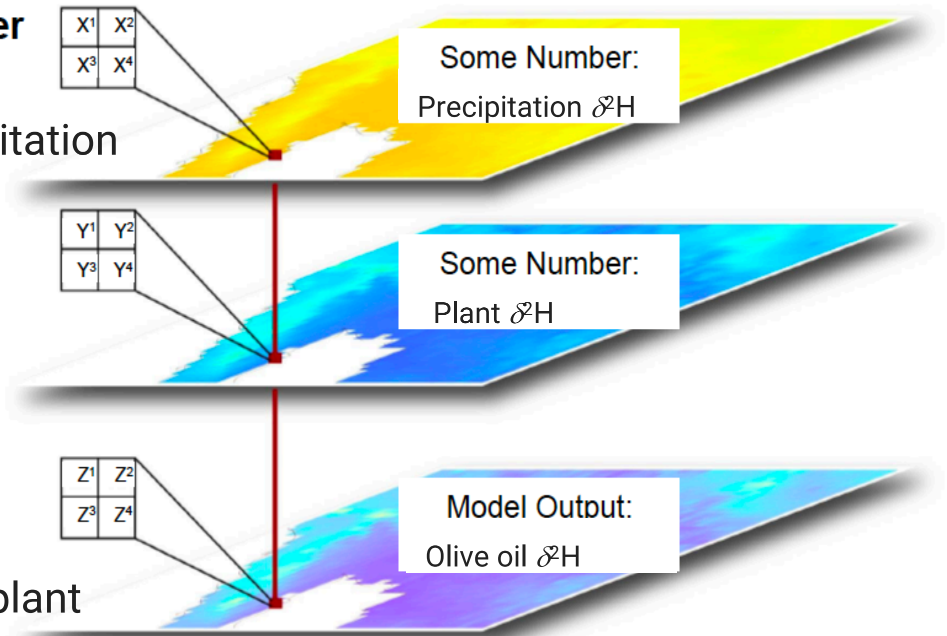
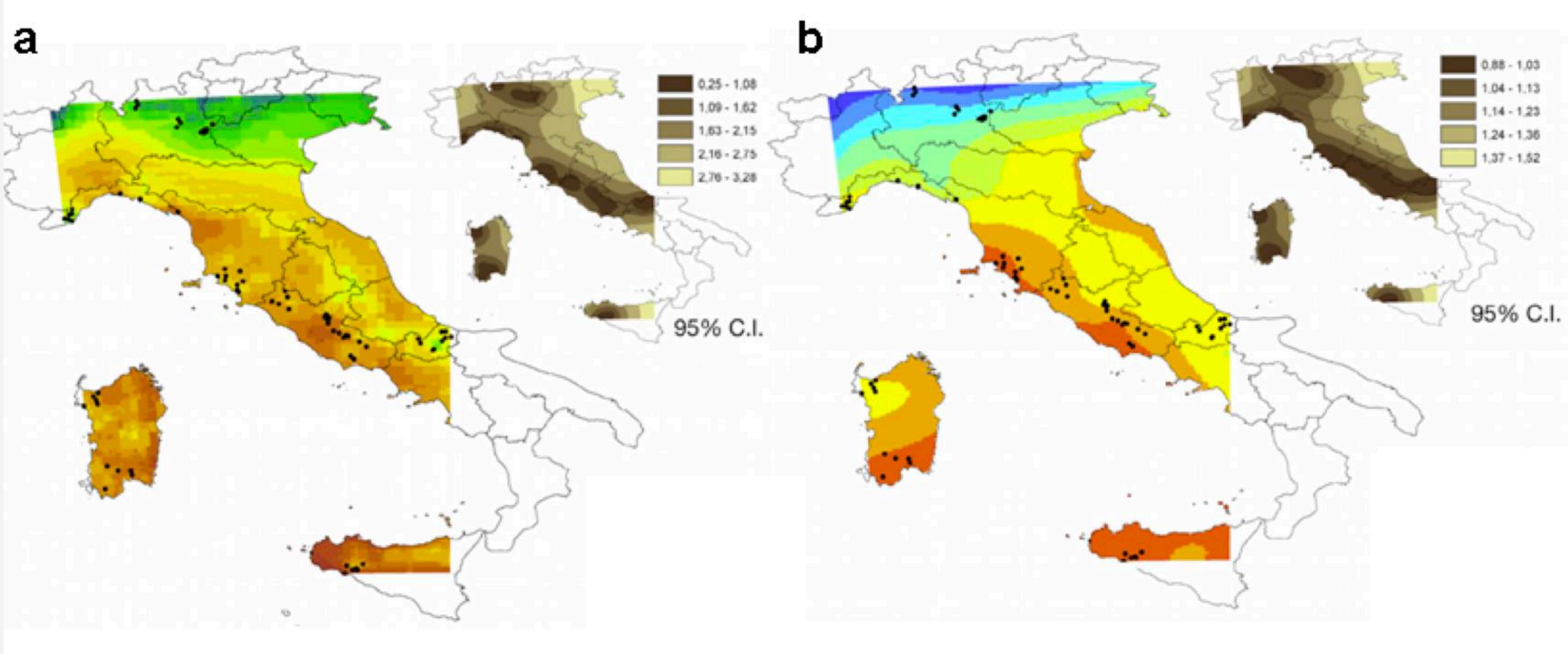


Figure courtesy of Jason West

(Real) example – build an oil isoscape



3.
ISO-FOOD ontology

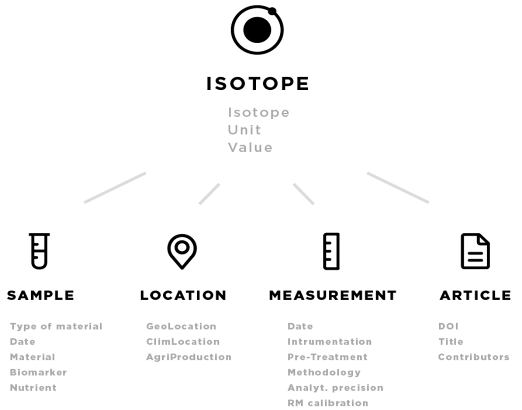
isotopes used for food research

Why we need a centralized repository for isotopic data

PNAS 114, 2997-3001, 2017

Jonathan N. Pauli[a,1], Seth D. Newsome[b], Joseph A. Cook[c], Chris Harrod[d], Shawn A. Steffan[e,f], Christopher J. O. Baker[g], Merav Ben-David[h], David Bloom[i], Gabriel J. Bowen[j], Thure E. Cerling[j], Carla Cicero[k], Craig Cook[h], Michelle Dohm[l], Prarthana S. Dharampal[f], Gary Graves[m,n], Robert Gropp[o], Keith A. Hobson[p], Chris Jordan[q], Bruce MacFadden[r], Suzanne Pilaar Birch[s,t], Jorrit Poelen[u], Sujeevan Ratnasingham[v], Laura Russell[l], Craig A. Stricker[w], Mark D. Uhen[x], Christopher T. Yarnes[y], and Brian Hayden[z]

IsoBank - organize, consolidate, and share stable isotope data across disciplines



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journal homepage: www.elsevier.com/locate/foodchem

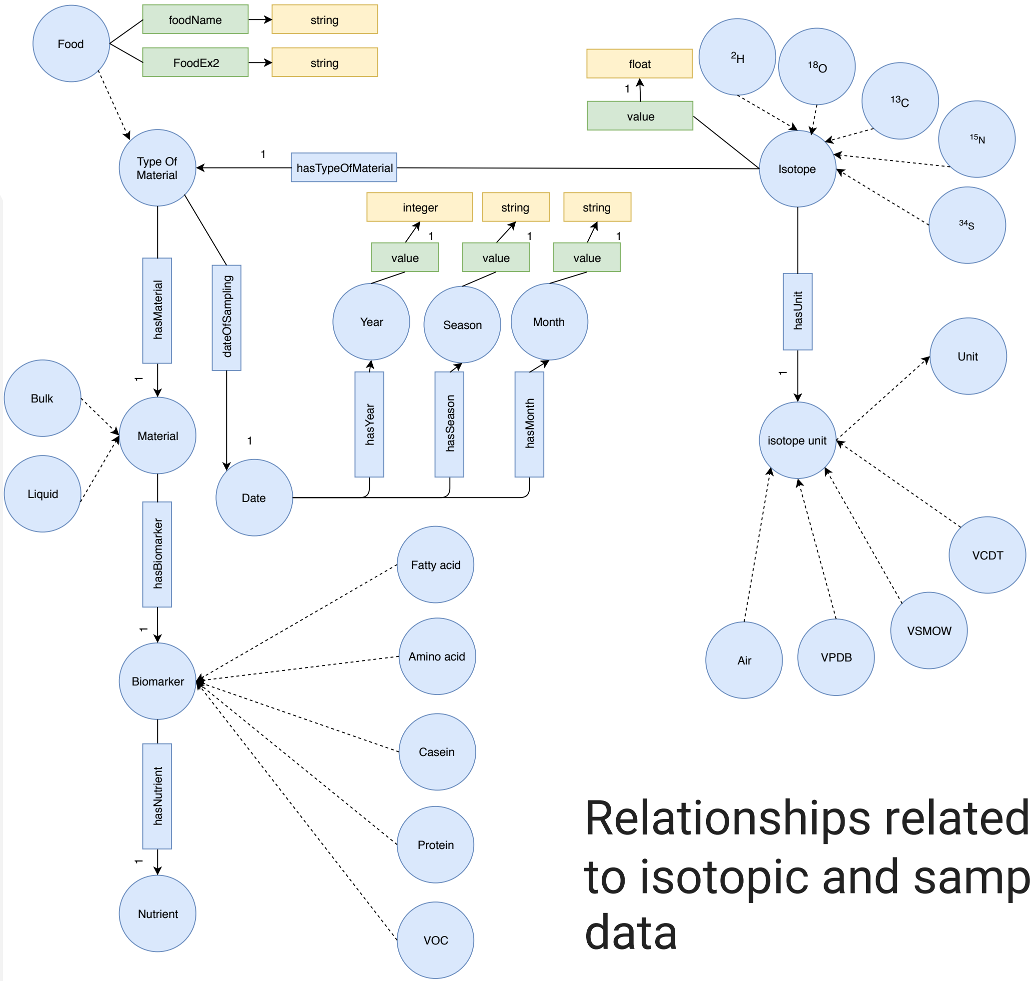
ISO-FOOD ontology: A formal representation of the knowledge within the domain of isotopes for food science

Tome Eftimov[a,*], Gordana Ispirova[a,b], Doris Potočnik[b,c], Nives Ogrinc[b,c], Barbara Koroušić Seljak[a]

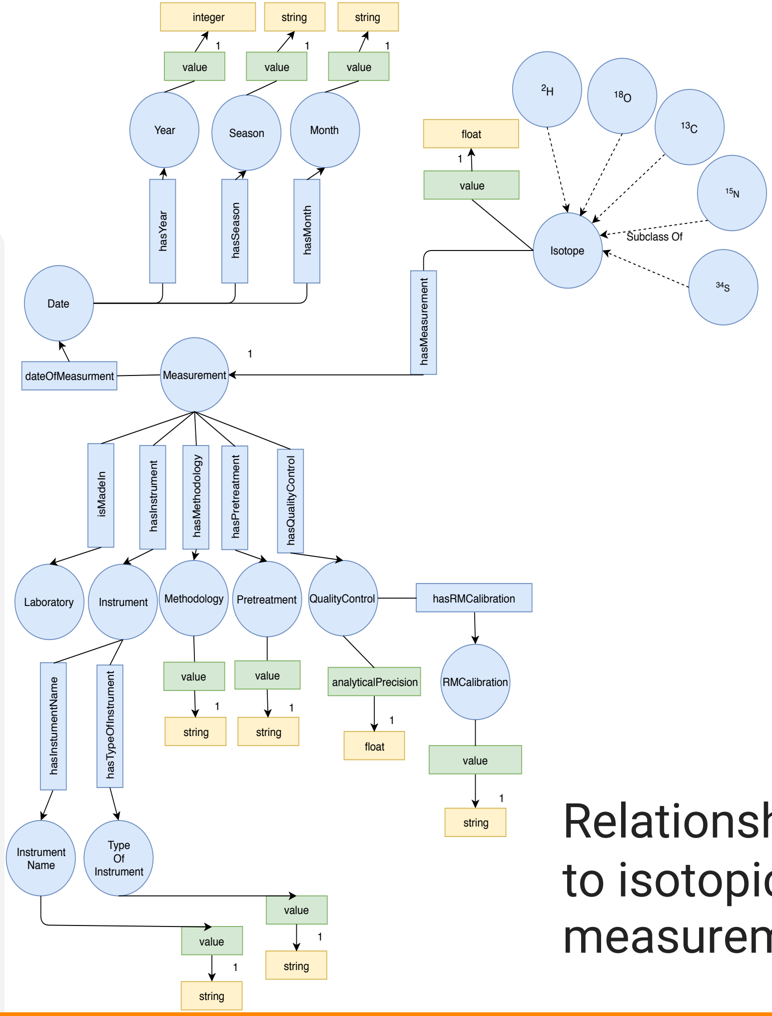
[a] Computer Systems Department, Jožef Stefan Institute, Jamova cesta 39, 1000 Ljubljana, Slovenia
[b] Jožef Stefan International Postgraduate School, Jamova cesta 39, 1000 Ljubljana, Slovenia
[c] Department of Environmental Sciences, Jožef Stefan Institute, Jamova cesta 39, 1000 Ljubljana, Slovenia

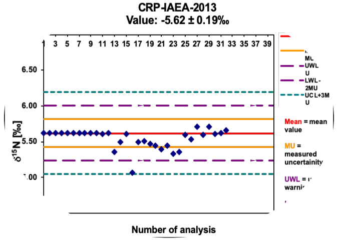
Link to RICHFIELDS ontology (Food) and EFSA (FoodEx2)

ISO Fd Food ERA Chair

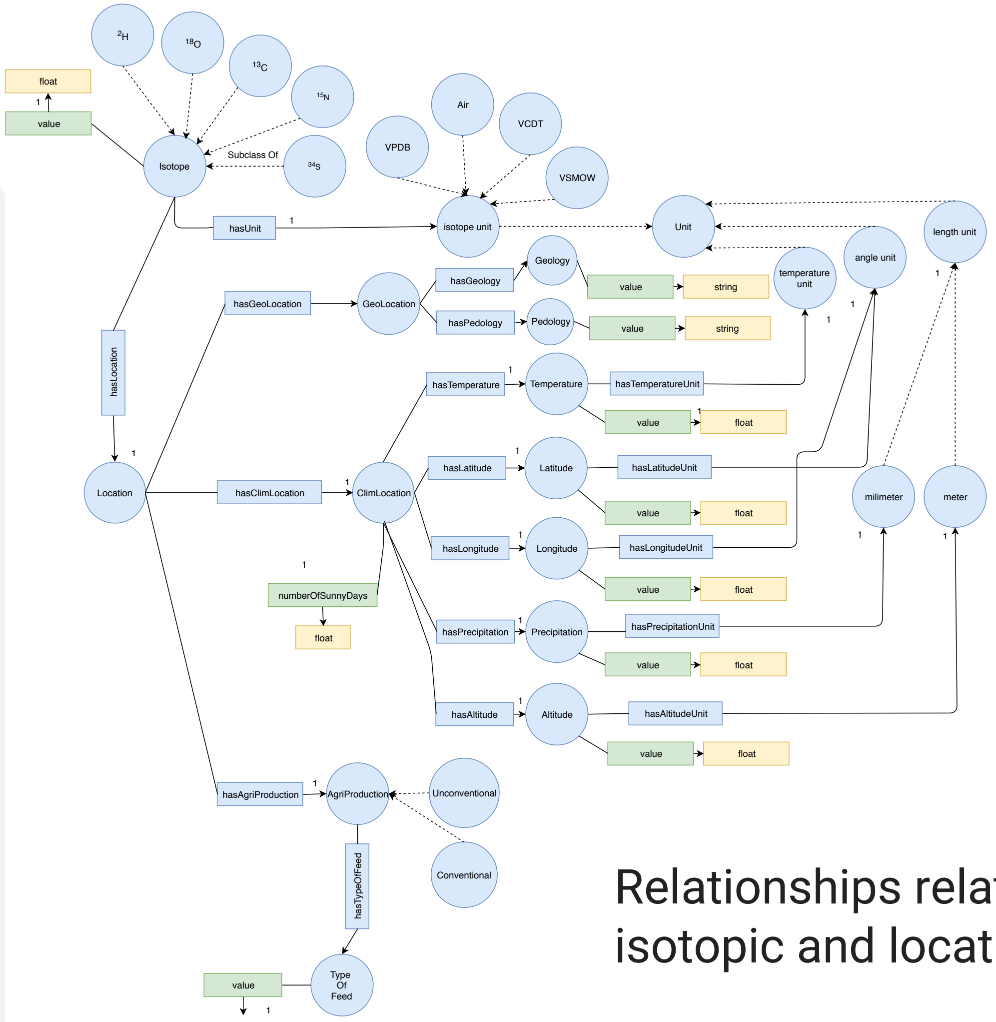


Relationships related to isotopic and sample data

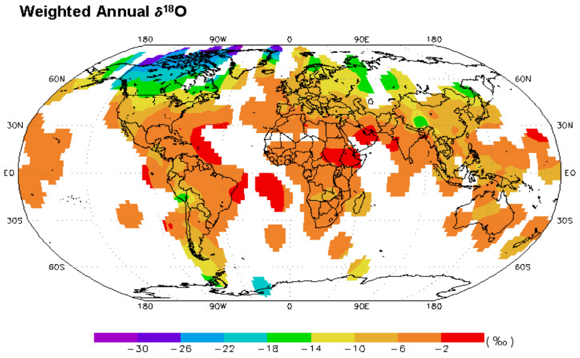




Relationships related to isotopic and measurement data



Global Network of Isotopes in Precipitation (GNIP) managed by IAEA and data operating by University of Utah, USA (http://isomap.rcac.purdue.edu:8080/gridsphere)



Relationships related to isotopic and location data

Potential users

FOOD BUSINESS OPERATORS

POLICY MAKERS / FOOD INSPECTIONS & CONTROL

RESEARCH/ACADEMIC

CONSUMERS / CITIZENS

Credits

ISO Fd Food ERA Chair

REAL Med

IAEA
International Atomic Energy Agency

arrs
SLOVENIAN RESEARCH AGENCY

FOOD 4 FUTURE

FNS-Cloud
Food Nutrition Security

METRO FOOD
Preparatory Phase

THANKS!

Any questions?

You can find me at nives.ogrinc@ijs.si